Student perceptions about participation in co-curricular engineering projects - an Institutional Study at Cal Poly San Luis Obispo.

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Abstract (300+ words)

Co-curricular team projects in engineering – like design projects, experimental assignments, or national project-based competitions or challenges – can be key experiences for students in forming personal and professional skills and traits. Little concrete data is available about why students choose to participate or not participate in such activities though, and how their participation and perceptions of the activities may be influenced by factors such as their gender identity, race/ethnicity, and other facets of themselves and their experiences. Without this data, it is difficult to conceive of strategies to improve participation in certain activities among groups of people who are otherwise under-represented compared even to their representation at the College level. The research was devised to gather insight into why students chose to participate or not participate, and what they felt the benefits and detrimental effects of participation were. The pilot study was conducted at the Cal Poly San Luis Obispo campus, which is part of the California State University system - it has a student cohort that is not particularly diverse compared to the rest of the system or highly representative of state demographics, and it has an institutional focus on applied, hands-on learning that means that a high number of students participate in co-curricular engineering projects. A 70 question survey tool, adapted from an existing tool, garnered responses from nearly 500 students, with demographic and identity questions preceding sections about factors that led to participation or non-participation, and then perceptions of positive and negative outcomes that can come from involvement in co-curricular engineering projects.

1. Introduction

Preparing students properly for the global workforce, and ensuring that engineering graduates have satisfactory skills that span both the technical and interpersonal, are national priorities (Clough, 2004). ABET requires institutions to provide opportunities for students to practice technical and professional skills, to develop creative thinking, problem-solving skills, teamwork, and general application of theory to practice – all notions that are developed or re-enforced in co-curricular engineering activities. Therefore, engaging students in applied project-based work that sits outside the classroom has been pursued by many institutions as a means of improving students' professional attributes and supplementing learning and formation in a hands-on way. Understanding how students are learning in co-curricular projects - when there is often little-to-no formal or informal assessment of their attainment of concepts or practice or connections to the curriculum and beyond - is undoubtedly difficult but useful given the voluntary time, effort and resources that many students apply to engineering projects for which they most often obtain no academic credit. Properly understanding *why* they choose to participate in the first place is just as vital, but we know exceptionally little about this (Yu et al., 2015), which also severely limits our ability as educators to ensure that students who are under-represented in engineering are able to access and take benefit from such experiences.

The research described here was aimed at addressing the following questions, based on preliminary analysis of survey data that will later be used to glean a greater depth of insight into the role of gender, ethnicity, and other potentially influential factors that influence participation in projects (and student attitudes towards that participation or otherwise).

1) What are the perceived positive and negative outcomes of participation in co-curricular engineering activities that students at Cal Poly feel the most strongly about?
2) Are there significant differences in those perceptions and the emphasis placed on them by different demographic groups?

Co-curricular activities are increasingly recognized as "the place where it all comes together." Participation in activities outside the curriculum has been shown in some circumstances to be a more accurate predictor of workplace competence than grades (Kuh, 1995)**.** Carberry et al (2013) found that among 261 engineering students, 45% of their technical skills and 62% of their professional non-technical skills were self-attributed to an engineering service experience. For instance, in one significant study into where engineering students encounter ethical considerations (Burt et al., 2011), 30% of 4000 indicated regular participation in project-based "clubs".

Note that in this research we refer to co-curricular activities as strictly those which align well with the major subject area (engineering) and typically provide students/members with a project-based experience (e.g. Formula racing, Concrete Canoe, Robotics Club, etc.). They are usually associated with no formal academic credit. We explicitly exclude professional/social development societies and organizations like Society of Women Engineers or Society of Hispanic Professional Engineers from this category as, while they may involve some project activity, that is not their main purpose or engagement for all their members. We define extracurricular as being largely unrelated to the major subject area, such as athletics, band, scuba diving club, and similar activities. These distinctions were spelled out to students in the

course of completing the survey described in section 2, to ensure that there would be little to no confusion as to the nature of activities in question for the present research.

Yu and Simmons (2015) looked at available research between 2000 and 2013 identified only four peer-reviewed investigations that dealt directly with factors related to student participation in any co-curricular activity (undergraduate research, service learning, and others), and only one dealt directly with *reasons* for student participation. Some reasons for the lack of data and study may be obvious: occasionally, faculty advisers are not deeply involved (emotionally or professionally) in the student organization, and students working on projects for competitions or other events are unlikely to find themselves being assessed and may therefore conduct relatively little self-reflection without explicit prompting - leaving an open-ended question as to how and by how much they have actually developed professionally and personally, let alone why they participated in the first place.

Simmons et al. (2015) attempted to better understand under-represented engineering students' involvement in activities, and developed a Postsecondary Student Engagement Survey (PosSE, discussed in greater detail in section 2, since this methodology is being adapted in part for the present proposal). The holistic study references all "out of class" activities, including those not at all associated with engineering. The study was the first one of its kind but was limited to 10 students (as befits a trial of the methodology before the approach is finalized and rolled out on a larger scale). At that time the authors stated "currently there exists no valid and reliable survey that comprehensively measures… reasons for and for not participating in out-of-class activities." In terms of why students choose to participate, anticipated positive benefits may be only one of many reasons to join or not, and the benefits may not be perceived to outweigh downsides. The study's widescreen focus on all possible activities yields a wealth of new information, but very little of it discernibly to do with hands-on engineering project activities of the type that are common on many university campuses, and the study is premised on the foundation of engineers being reluctant to participate and a need to know why – this is not our experience at Cal Poly, where a vast number of project experiences are available to, and popular with, engineering students.

Simmons et al (2015) also asked of both literature and research subjects "what demographic and institutional characteristics are associated with engineering students who participate in out-of-class activities?" – we will further refine this area of inquiry to focus specifically on co-curricular engineering projects. Students with a strong stated intent to work in engineering upon graduation were more likely to involve themselves in purely-engineering activities. Holland et al (2011) undertook a qualitative study of 62 students comparing participation from a historically-Black college and a primarily white institution – they found that female students were more interested in activities with a strong professional orientation, with males more interested in less formal interactions with peers and alumni. The researchers uncovered intrinsic motivations such as powerful interest in their major, valued interactions with peers, and a break from coursework being desirable. Extrinsic motivations included improving their marketability to industry. Scheduling and lack of information were cited as frequent stumbling blocks to participation, with faculty encouragement and peer/role-model encouragement enhancing likelihood of involvement.

Estrada (2014) concluded that engagement in co-curricular activities helps to strengthen underrepresented minority (UMR) students' continued interest in a STEM career. Normally these students have lower rates of participation in co-curricular activities due to lack of social cohesion. In addition to creating an engaging environment for students, universities need to consider the psychological factors that motivate students to spend their extra time participating in co-curricular activities. Estrada concluded that the relationship between self-efficacy, identity, and resilience plays the largest role in motivating a student the invest time in a co-curricular program. While these traits are mainly dependent on the individual, they can be developed through a positive, supportive academic setting. With increased traits like self-efficacy, the apparent barriers that prevent students from engaging decrease. Students will also begin to develop a more clear personal identity that could help improve their long term interest in the STEM field. Insight into what motivates students to continuously engage in these beneficial programs can help universities to create a more supportive environment that will encourage UMRs to participate.

For the present research we have attempted to focus our efforts on better understanding student *perceptions* around engaging in co-curricular activities (expected positive or negative outcomes), comparing answers from those who either did or did not participate at a single institution. Viewing the responses through an identity-based framework dealing with gender and race/ethnicity would begin to highlight differences in attitudes and experiences from groups, though we stress that this is a first pass through a large amount of data which will require closer analysis.

Cal Poly San Luis Obispo is a primarily-undergraduate institution, part of the multi-campus Cal State system and, being a polytechnic, noted for its focus on engineering and science subjects in particular. The campus has the least diverse student cohort in the Cal State system, with over 50% of students reporting as white in the College of Engineering. Female enrollment is at around 25% though this varies widely across departments. Cal Poly has an explicit mission of “Learn By Doing” which has resulted in the creation of between 35 and 40 funded hands-on co-curricular project experiences available in Engineering alone, not counting other related experiences such as research, internships, etc. As a result, student participation in co-curricular activities is assumed to be high relative to other campuses that do not offer nearly as many potential activities. It is in this context that we decided to better understand the student decision-making process surrounding their engagement or lack of participation in co-curricular engineering projects.

2. Methodology

2.1 Design of Research and Data Gathering

All data was gathered from an online survey (the full questions appear in Appendix B, with the ones focused on for this paper highlighted in Appendix A). This was supplemented with more detailed information obtained from several semi-structured interviews with respondents who participated in the aforementioned survey. The online survey was adapted from the constructs presented in Developing the Postsecondary Student Engagement survey (PosSE) to Measure Undergraduate Engineering Students Out of Class Involvement (Simmons et al. 2015). PosSE consists of eleven constructs developed using Q-methodology; PosSE analyzes the satisfaction, sense of belonging, level out of class involvement, and other relative concepts. Since the PosSE survey tool was thoroughly developed through workshopping the

questions and potential answers with a variety of students to ensure a very comprehensive range was covered, the present tool was not extensively modified. However, because PosSE also accounts for *all* activities outside this project's definition of co-curricular activities, we modified some items in the following PosSE constructs to fit the scope of our project: Factors that Promote Participation, Factors that Prevent Participation, Expected Positive Outcomes, and Expected Negative Outcomes.

In order to distinguish between students who have and have not participated in co-curricular engineering activities, the online survey was designed with three sections. The first section contained an informed consent form, and the second section contained fourteen demographic questions on gender, race/ethnicity, pell grant status, academic standing, etc. Students were able to self-report their race/ethnicity by typing, rather than choosing from a prescribed list. Unlike the previous two sections, which were open for all survey respondents to answer, the third section spilt survey respondents based on whether or not they participated in a co-curricular engineering activity in the last twelve months. Using the logic function of the online surveying tool, those who indicated involvement in a co-curricular were automatically directed to rank fifteen factors that they may have felt directly promoted their participation in a co-curricular activity on a five point Likert scale. Similarly, those who indicated no participation ranked fifteen factors that may have limited their participation in a co-curricular activity on the same scale. All respondents were then directed to rank eleven perceived positive outcomes and eleven negative outcomes of participating in co-curricular activities, regardless of whether they participated or not. Respondents were also given the option to enter a random-draw raffle for a chance to win one of 4 fifty dollar gift cards, as incentive to drive survey completion.

A pilot survey was conducted with 6 students to ensure the online survey functioned correctly, and to garner feedback about its usability and understandability. Only minor changes were required after this to roll out to the wider engineering population. For the main survey, a link was emailed to the entire College of Engineering student cohort at Cal Poly as a census. In addition, specific promotion was asked of several of Cal Poly's minority-serving clubs/organizations to its engineers (National Society of Black Engineers, Queer Transgender People of Color, etc).

2.2 Observational Unit

The approach outlined above constitutes a self-reported observational study. The population of interest is the engineering students at Cal Poly in June 2018. While primarily intended for engineers and disseminated to engineering groups, there were no specific measures in place to prevent non-engineers from filling out the survey. Since this was a distributed as a census, data from the pilot and main survey were included in the frame analyzed. Incomplete responses were later deleted from the data set to make analysis more streamlined and reliable.

2.3 Response and Explanatory Variables

The response variable of interest for the project is "Have you participated in a co-curricular activity in the past 12 months?". As expressed in the research question, we wished to determine what differences in perceptions of positive and negative benefits may exist between students who choose to join or not join a co-curricular engineering activity.

This was measured against our explanatory variables from the "Expected Outcome" section of the survey (positive or negative results that could stem from participation) all students responded to; questions 47-68 from the survey in Appendix B. Additionally, these variables were analyzed across the demographics of gender (cis-man and cis-woman) and race (Asian, Latinx, multiracial, white) for comparison.

2.4 Analysis procedure

All statistical analysis was completed using JMP Pro 14 software. To gain insight on the distribution of our survey participants with regards to our response variable and explanatory variables, we made use of the *distribute* function. The explanatory variables followed a similar procedure, recording the response rate of strongly agree, agree, neutral, disagree, strongly disagree, and making note of the distribution. In addition, each explanatory response category was assigned a value based on the Likert Scale (1-Strongly Disagree, 2- Disagree, 3 - Neutral, 4 - Disagree, 5 - Strongly Disagree) and the values averaged for each question. To understand the association between the response variable and the explanatory variables, the distribution function was once again used. One item from the survey was selected at a time as the variable of interest and compared with the response variable. We recorded the response rate of strongly agree, agree, neutral, disagree, strongly disagree, and made note of the distribution for each response by their respective answer to yes or no to co-curricular participation. This procedure was repeated for each demographic category mentioned above. To test for statistical significance of our explanatory variables with our response variables, a Chi-Square Test was conducted to retrieve a p-value.

3. RESULTS

3.1 Descriptive Statistics

Sample Demographics

In total, 550 survey responses were collected using the online surveying tool. All analysis, results, and conclusions stated in this paper were drawn from the final cleaned dataset which totaled 476 respondents. Depicted in Table 1 is the demographic breakdown of both the survey respondents and the Cal Poly College of Engineering (CENG) based on institutional statistics correct as of 2016/17. Cis men constituted more than half (n=259) of all total survey respondents in the gender category, but were underrepresented in this survey in comparison to their overall makeup (74.4%) of the CENG. Cis women only makeup 25.6% of the CENG but responded to the survey at a rate of 43.3% (n=206). Genderqueer, non-binary, transgender, and unsure/questioning students, respectively constituted less than one percent of survey respondents. Because there is no published data on the demographics of students with the aforementioned gender identities, this project is unable to determine whether the data gathered in the survey is representative of the CENG, but we would consider the numbers too small to make any valid analysis at this stage.

White students make up the largest racial group in both the survey (n=288) and the CENG (n=3,320); however, white students were overrepresented in this survey by almost ten percent. Asian students constitute the second largest racial group in both the survey and the CENG, and were along the lines of their demographic makeup. Latinx students were only 6.3% of survey respondents, but are 14.1% of the CENG. In itself, these numbers could be connected to anecdotal evidence that Latinx students may be under-represented in co-curricular projects on campus, even compared to their under-representation in the

college cohort. However, multiracial respondents were 13.5% of respondents, almost double their CENG constitution. There were only two black survey respondents, yet their survey constitution (0.4%) was similar to their CENG composition (0.7%).

Table 1. Demographics of respondents vs. Cal Poly College of Engineering

	Total Survey Respondents (N=476)		Total Students in College of Engineering (N=6,421)	
Characteristic	**Number of Students**	**Percentage**	**Number of Students**	**Percentage**
Gender				
Cis man	259	54.4	4,778	74.4
Cis women	206	43.3	1,643	25.6
Genderqueer	2	0.4	Unknown	Unknown
Non-binary	3	0.6	Unknown	Unknown
Transgender	1	0.2	Unknown	Unknown
Unsure/Questioning	4	0.8	Unknown	Unknown
Race/Ethnicity				
Asian	78	16.4	1,131	17.6
Black	2	0.4	47	0.7
Latinx	30	6.3	905	14.1
Multi-Racial	64	13.5	503	7.83
Native American	0	0	2	< 0.001
Native Hawaiian/ Pacific Islander	0	0	6	<0.001
Non-residents	0	0	209	3.3
White	288	60.5	3,320	51.7
Unknown	14	2.9	298	4.6

Co-curricular engineering project participation

Of the 476 student respondents in the sample collected, 54.83% students indicated they participated in a co-curricular engineering project activity in the past year. A breakdown of co-curricular participation by demographics with more than 5 respondents can be seen in Table 2. Separated by gender, cis men had a participation rate of 56.9% and cis women 51.9%, indicating relatively similar participation rates, with cis men above average participation and cis women below. When separated by race and ethnicity, participation of students identified as white was 57.6%, Asian 47.4%, multi-racial 54.6%, and Latinx 43.3%. Therefore Asian and Latinx students were significantly below the average participation rate of students as compared to white students, and multi-racial students are at about the average.

Table 2. Summary of response variables by gender and race/ethnicity

Demographic	Total of Demographic who Participated in a Co-curricular	Percentage	Total of Demographic who didn't participate in a Co-curricular Activity	Percentage	Total Demographic
Gender					
Cis women	107	51.9	99	48.1	206
Cis man	140	56.9	106	43.1	246
*Other	14	58.3	10	41.7	24
Race/Ethnicity					
Asian	37	47.4	41	52.6	78
Latinx	13	43.3	17	56.7	30
Multi-Racial	35	54.7	29	45.3	64
White	166	57.6	122	42.4	288
Other	10	58.8	7	41.2	17

Perceived Outcomes that Promote or Prevent Co-Curricular Participation

The average responses to the perceived expected outcomes from joining a co-curricular can be seen in the Likert scale average in Figure 1 and Figure 2; the items are ordered from strongest agreement to strongest disagreement, and green indicates a potential positive benefit while yellow indicates a perceived potential negative outcome. The value of their averages are also listed according to their demographic identity in Table 4 of Appendix A. The expected positive outcomes that appear to be the most important toward promoting general participation are *Career and professional development, Intellectual development,* and *Connection with your discipline*. All three of these factors were above the Likert average for women and multi-racial students. All other demographics rated below the average besides white students who matched the average of *Connection with your discipline*. Worth noting is that women rated all factors that promote participation higher than average.

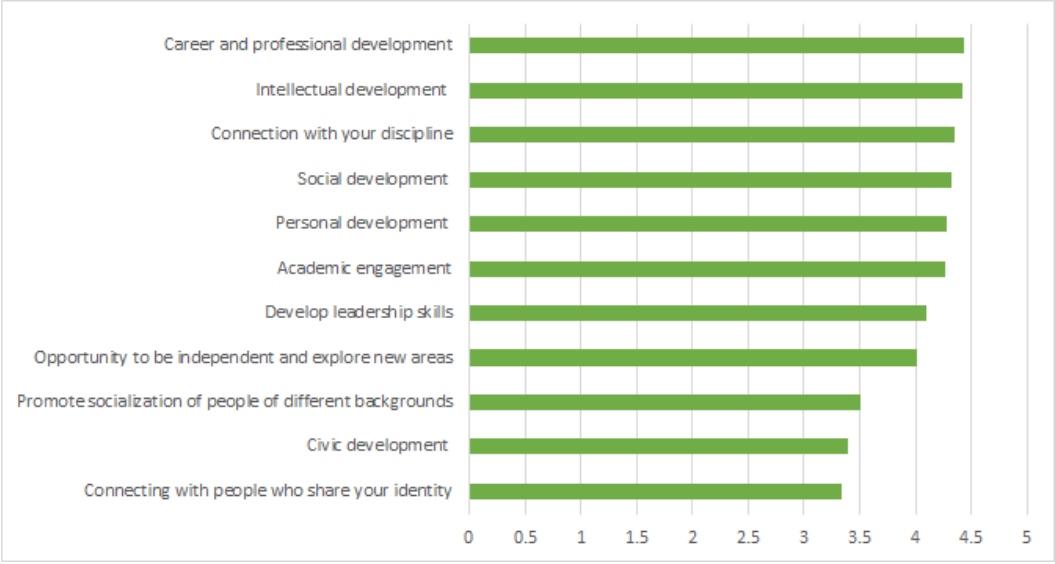

Figure 1. Likert scale averages of expected positive outcomes for the standard (mean) respondent

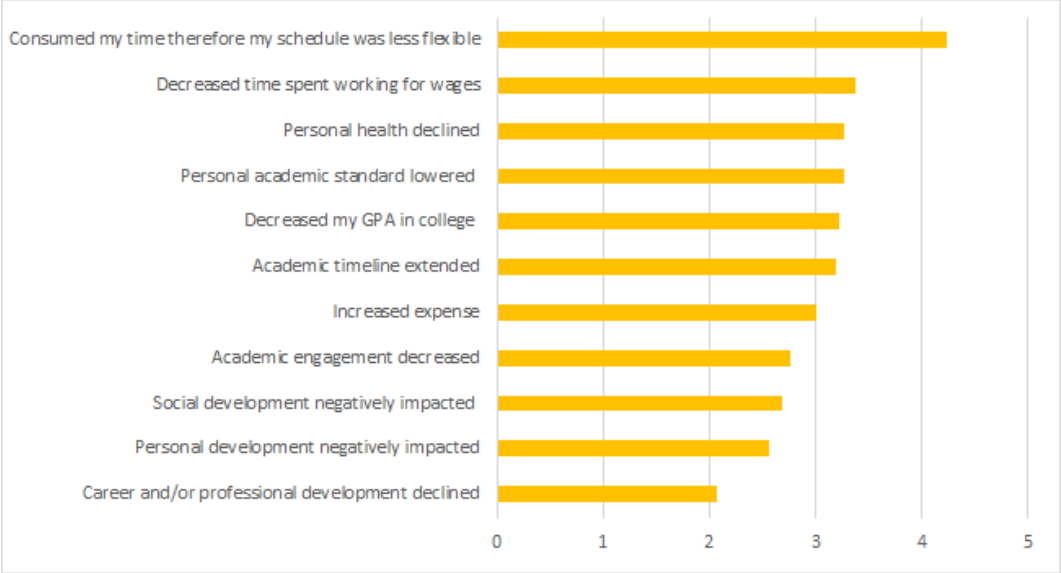

Figure 2. Likert scale averages of expected negative outcomes for the standard (mean) respondent

The most significant expected outcomes that negatively impacted potential participation were *Consumed my time therefore my schedule was less flexible, Decreased time spent working for wages,* and *Personal health declined*. Asian students rated *Career and professional development declined* as a reason for not participating above the Likert average and multi-racial rated it below the average. *Personal development negatively impacted* was rated significantly higher than average for Latinx students and below average for multi-racial. All demographics ranked *Social development negatively impacted* at about its mean.

Perceived Expected Outcomes by Participation in Co-Curricular

A first look at potential association between a student's perception of the expected outcomes and their participation in co-curricular activities can be seen in Appendix B Tables 6 to 13. Table 13 below shows this association for a negative outcome: *Academic timeline extended*. In particular, note that the grouping that had not participated in a co-curricular activity had a significantly higher percentage of students who "Agree" that academic timeline extension is a disincentive, as compared to students who have participated. Figure 3 provides a visualization of this interaction. On the left we see the overall distribution of responses, which is then broken up by those who participated and those who did not. The association is worth noting for these factors, *Intellectual development, Personal development, Academic timeline extended, Career and/or professional development declined, Decreased my GPA in college, Increased expense,* and *Decreased time spent working for wages*.

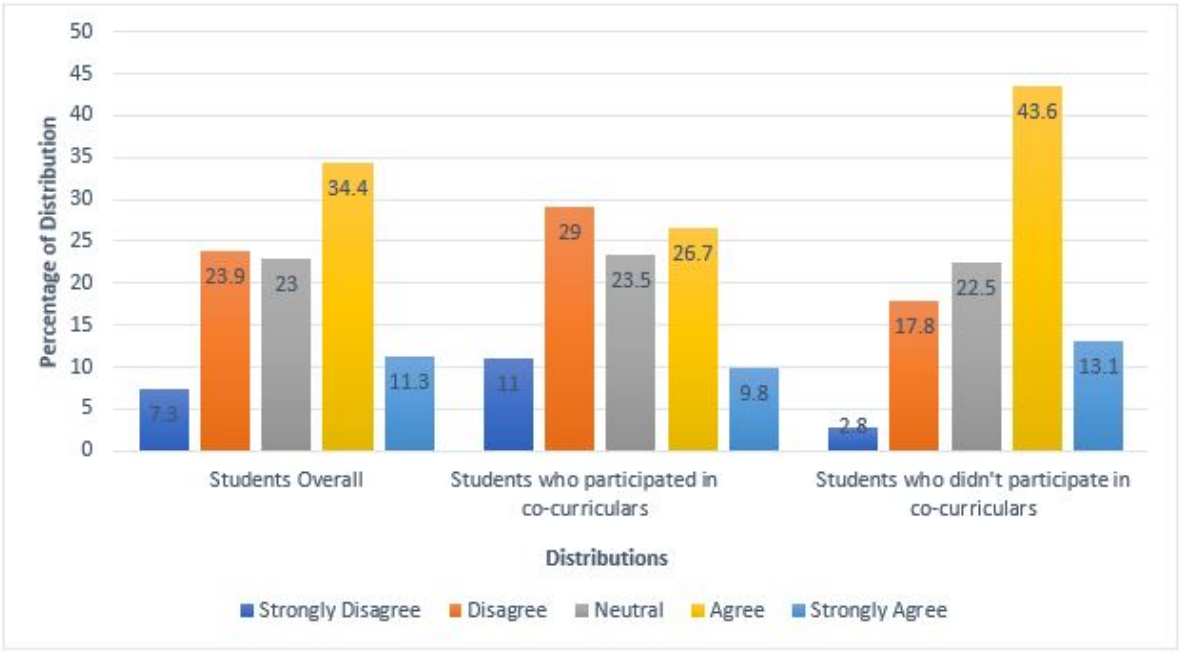

Figure 3. Standard (mean) Respondent Academic Timeline Extended Response Distribution Overall Comparison to Standard (mean) Respondent Distribution Contingent on Participation in Co-Curricular activities

This same visualization is undertaken by demographics in Figures 4 to 9. The distributions by demographic on the left side of each figure follows a similar distribution to the standard respondent. On the right side of each figure this is once again separated into students who did and did not participate in a co-curricular. Notably the distributions for cis males, cis females, white, Asian and multiracial students are similar to the standard respondent, all had a more pronounced "Agree" among students who did not participate compared with students who did. A significant exception is from those identifying as Latinx, in this case those who participated and those who did not had a large amount of students with "Agree". For Latinx students, the factor may not distinguish between those who did and did not participate, but is worth noting for the difference between Latinx and other demographics.

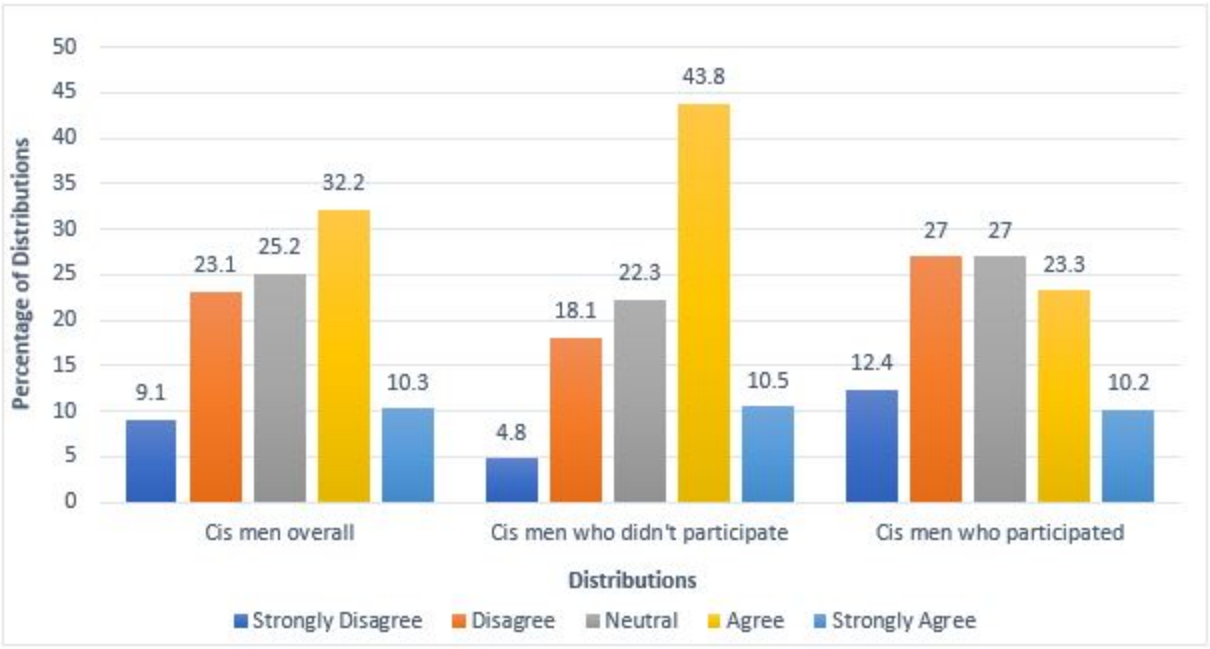

Figure 4. Cis Men's Academic Timeline Extended Response Distribution Overall Compared to Cis Men's Response Distribution Contingent on Participation in Co-Curricular activities

3.2 Inferential Statistics

The Chi-square test was used to determine which factors maybe the most statistically significant. With many variables, the potential for false positives was avoided by using a prediction model to find those most relevant to the sample. Additionally, certain factors did not meet the validity conditions for the chi-square test, usually with insufficient responses in a particular category. The factors passing the initial Chi-square test with a significance level of .05 were *Intellectual development, Personal development, Academic timeline extended, Career and/or professional development declined, Decreased my GPA in college, Increased expense,* and *Decreased time spent working for wages*. Gender and race were not statistically significant on their own. The results with the full set of p-values for each explanatory variable are provided in Table 5 in the Appendices.

The model we used includes the following factors: *Intellectual development, Academic timeline, Career and/or professional development declined*, and adjusted for with *decreased time spent working for wages*. With a p-value of .0001, this model is found to have a statistically significant association with a student's choice to join or not join co-curricular projects. The R-square value, which measures the amount of variability the model explains, is 11.5%.

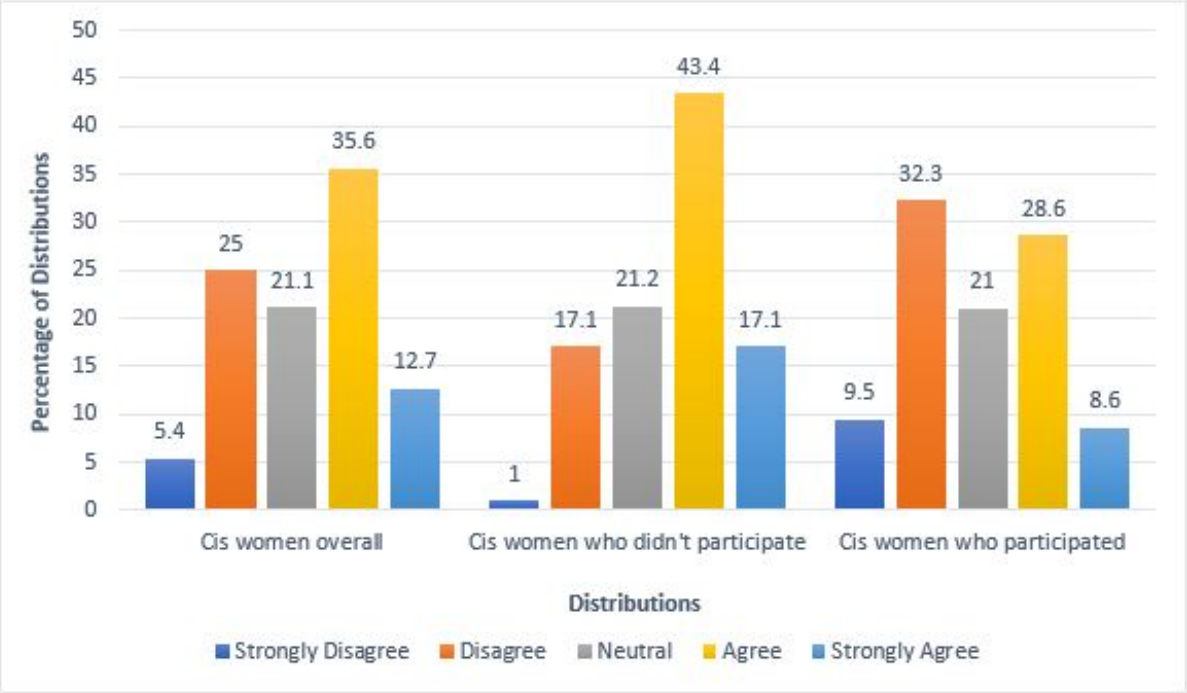

Figure 5. Cis Women's Academic Timeline Extended Response Distribution Overall Compared to Cis Women's Response Distribution Contingent on Participation in Co-Curricular activities

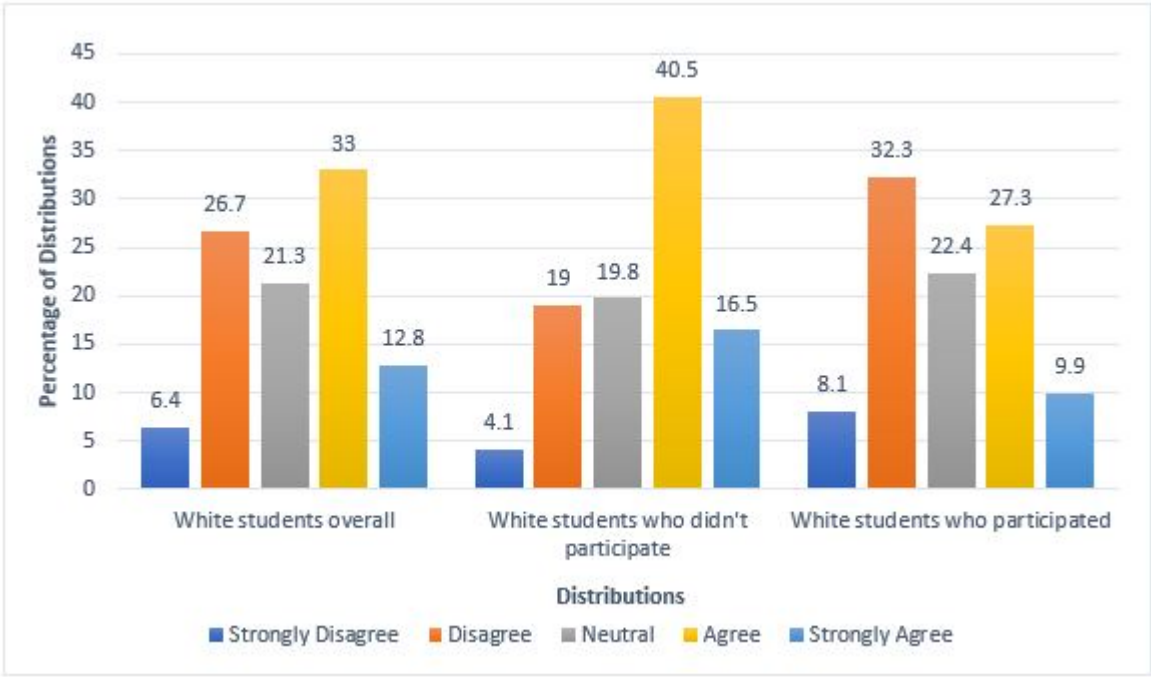

Figure 6. White Students' Academic Timeline Extended Response Distribution Overall Compared to White Students' Response Distribution Contingent on Participation in Co-Curricular activities

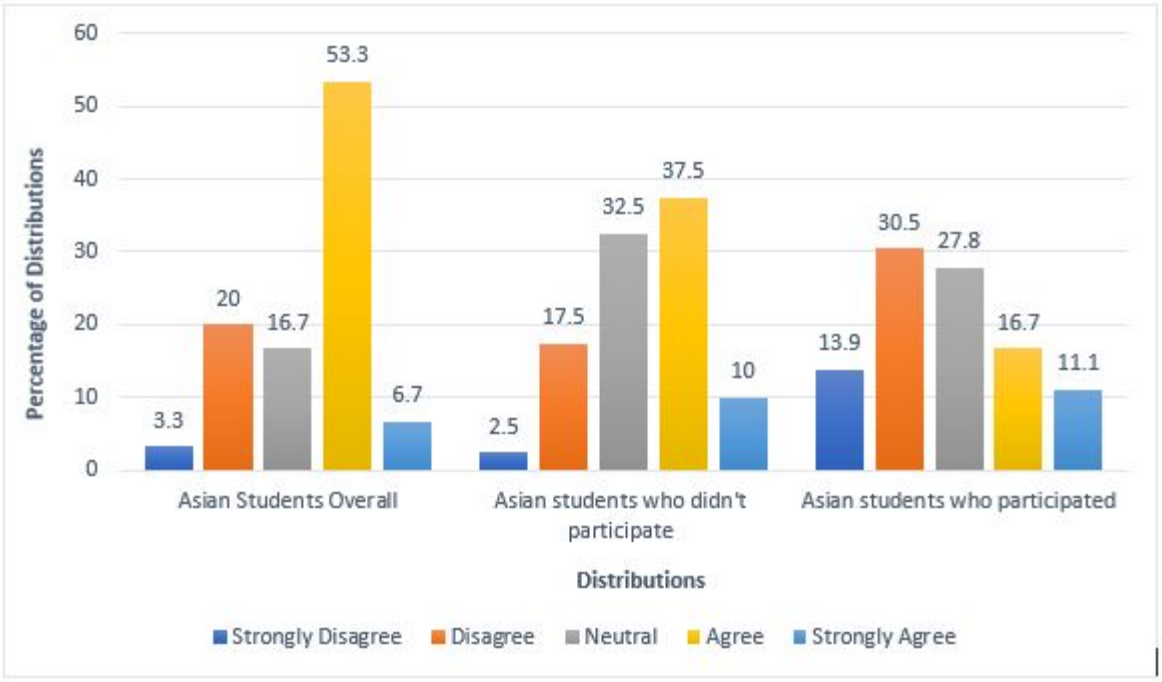

Figure 7. Asian Students' Academic Timeline Extended Response Distribution Overall Compared to Asian Students' Response Distribution Contingent on Participation in Co-Curricular activities

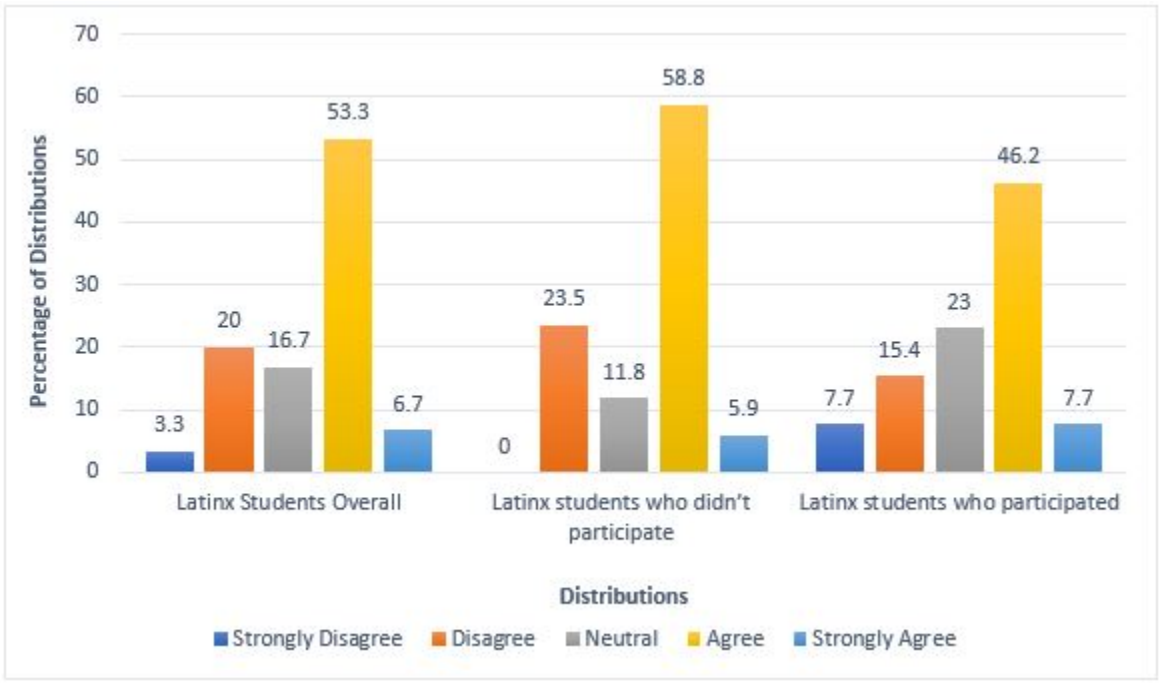

Figure 8. Latinx Students' Academic Timeline Extended Response Distribution Overall Comparison to Latinx Students' Response Distribution Contingent on Participation in Co-Curricular activities

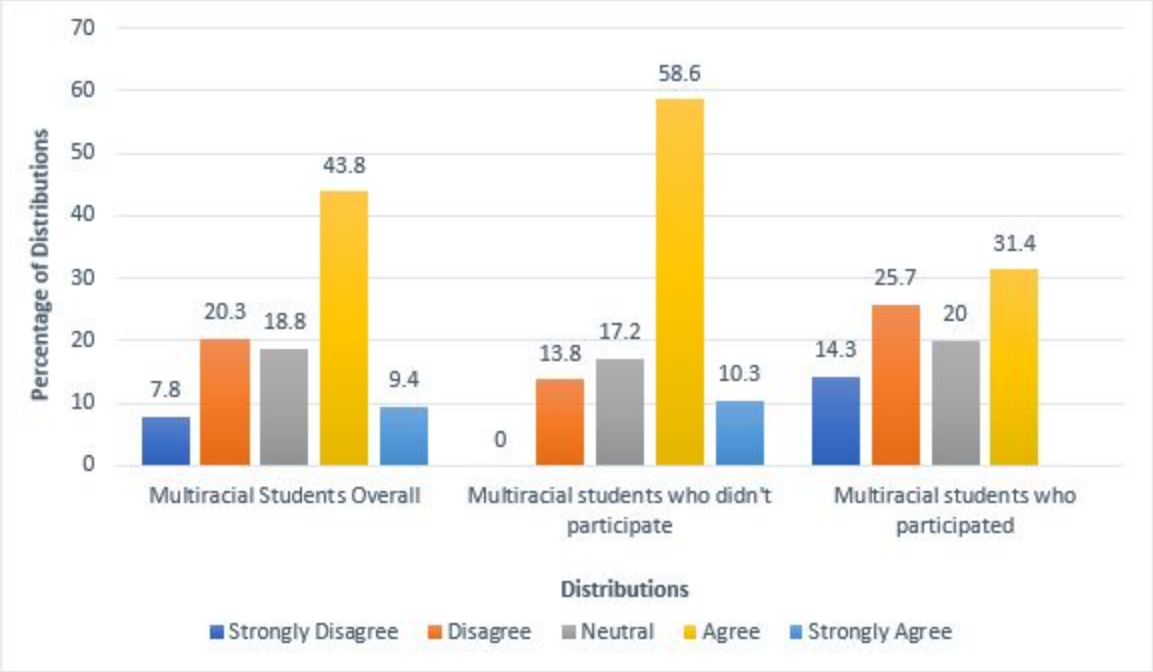

Figure 9. Multiracial Students' Academic Timeline Extended Response Distribution Overall Compared to Multiracial Students' Response Distribution Contingent on Participation in Co-Curricular activities

4. Discussion and Preliminary Conclusions

With little information on the decision for students to join or not join co-curricular activities, this study is intended to be exploratory and based on student perceptions of positive and negative outcomes, ignoring for now more specific reasons for why they actually did or did not participate (which will form the basis of continued work). In this regard, a wide net was cast with the intention of paring down to information worth further investigation. This is especially important in the context of finding sources that have the greatest impact on the decision to participate in co-curriculars.

From our sample, we had significantly higher participation rates among some groups of under-represented students as compared with their demographic make-up in the college. For instance, cis women make up 25.6% of the Cal Poly College of Engineering but were 43.3% of the respondents. Any future study may wish to account for this in their sampling techniques to have an improved representative sample. Even with this in consideration, white and male students had higher participation rates then their underrepresented counterparts.

Student perception of expected outcomes provides a raw interpretation of what students as a whole consider important in their choice to join or not join co-curriculars, even if they were not able to for other reasons. *Career and/or professional development* ranks high in this regard, both as an incentive for joining and a disincentive if their worry is its decline. There is no significant difference in this regard among those who do and don't participate, when it comes to this factor's importance. This is also true of *social development* and *academic engagement* for incentives to join and *consumed my time* as a

disincentive. While there may not be a distinction in terms of those who do and don't participate on these factors, it is worth further investigation to understand why students overall feel strongly about these items.

An interesting observation on the Likert Scale averages by demographic is how these demographics differ in their ranking of perceived outcomes. In Appendix A Table 4, as noted earlier, women seemed more enthusiastic about the perceived benefits of co-curriculars even as they had lower participation rates (though we note that at Cal Poly, female students are very likely to be associated with the Society of Women Engineers, which we deemed not to have enough engineering project activity to classify as a co-curricular by our definition, but may consume significant time and effort from the female students involved). However they also seemed to feel more strongly that there may be potentially significant negative outcomes. The largest gaps between men and women came under *Consumed my time* and *Decreased time spent working for wages*. Latinx students were almost always below the average of all students on perceived positive outcomes and above average on perceived negative outcomes, indicating that as a group, Latinx students may not think as highly of potential positive outcomes and placed more emphasis on the perceived negative outcomes. In light of Latinx student's low participation, it's worth further examination why this may be the case and if a change in perception among Latinx students that more closely reflects the standard students may help improve participation – this would involve a more detailed look at why those perceptions exist and whether they are accurate and valid or not for this demographic (e.g. whether a structural barrier needs removed, or whether more information and exposure would change a perception).

Also worth noting are that certain factors stand out as especially important to certain demographics. For instance, civic development ranked especially high among Asian students compared with the standard student. This maybe an avenue towards increasing participation if this aspect of co-curriculars were better promoted.

The model we used to associate student choice to join or not included factors *Intellectual development, Academic timeline, Career and/or professional development declined*, and adjusted for with *decreased time spent working for wages*. The adjustment accounts for overlap with other variables that might be statistically significant. In this case *Intellectual development, Academic timeline,* and *Career and/or professional development declined* are statistically significant in their own right. This indicates these three perceived outcomes play a significant role in differentiating the attitudes of students who decide to join compared with those who do not, however this does not exclude other sources of variation or even the other perceived factors. Indeed, the R-square value indicates only 11.5% of variation is accounted for between these two groups. It makes these factors worth a deeper look, but further investigation is needed to find other sources to explain the variation between students who join and do not join co-curriculars.

Certain factors may not have met criteria for the Chi-square test or otherwise may not be statistically significant, but are worth considering in observing the association between participation in co-curriculars and our other factors. The following items stand out: *Intellectual development, Personal development, Academic timeline extended, Career and/or professional development declined, Decreased my GPA in college, Increased expense,* and *Decreased time spent working for wages.* In Appendix B Tables 6 to 13 we note the differences in responses between students who joined and did not join co-curricular activities,

for instance a benefit of *Personal Development* had those who did not participate agree at 57%, and those who did participate strongly agree at 52%. For this reason an important consideration is that simply agreeing or disagreeing with a particular perception may not on its own affect participation, but how strongly a student agrees or disagrees with the statement which will color their attitudes to decision-making.

5. Future Work

The work presented here is our first look at a rich and significant data set that also includes interview material not discussed in this paper. At present, the survey described in this paper is being rolled out at several other universities in California that feature engineering programs but which have significantly different institutional profiles (public vs. private, large vs. small, research-intensive vs. primarily undergraduate) and/or gender or ethnic demographics in their engineering student cohort. This trove of new information will allow for stronger conclusions based on the identity factors we have focused on here, by reducing the dependence on data from a less diverse university that is unusually focused on undergraduate project experiences. It will also allow for more productive exploration of factors relating to international students or students for whom English is not a first language, which is rare at Cal Poly but prevalent at other universities. We anticipate using the present data to further investigate student decision-making through the lens of the "theory of planned behavior" (Ajzen, 1991), and to cross-correlate the survey data we have not explored here (statements about why did you choose to participate or factors which limited your participation) against the perceived positive and negative outcomes of participation to look for scenarios in which students do not participate but have highly favorable perceptions of benefits if they *do* participate, so that more specific barriers to participation can be identified for student groups.

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Appendix A

Table 4. Likert scale averages of student's perceived positive and negative outcomes

	Standard	Cis Man	Cis Woman	White	LatinX	Asian	Multiracial
Intellectual development	4.42	4.37	4.48	4.43	4.37	4.31	4.53
Personal development	4.27	4.22	4.34	4.27	4.03	4.29	4.36
Social development	4.32	4.27	4.40	4.34	4.03	4.32	4.42
Academic engagement	4.26	4.18	4.35	4.29	4.17	4.25	4.25
Career and professional development	4.43	4.39	4.48	4.46	4.37	4.34	4.48
Promote socialization of people of different backgrounds	3.50	3.37	3.66	3.48	3.27	3.66	3.44
Civic development	3.39	3.24	3.53	3.38	3.17	3.56	3.25
Develop leadership skills	4.09	4.02	4.18	4.13	3.80	4.04	4.14
Connection with your discipline	4.35	4.25	4.43	4.35	4.37	4.26	4.41
Opportunity to be independent and explore new areas	4.02	3.97	4.06	3.99	3.70	4.17	4.11
Connecting with people who share your identity	3.34	3.34	3.44	3.41	3.00	3.57	3.09
Academic engagement decreased	2.76	2.75	2.75	2.75	2.73	2.95	2.64
Academic timeline extended	3.19	3.12	3.25	3.19	3.40	3.09	3.27
Career and/or professional development declined	2.07	2.10	2.05	2.06	2.07	2.22	1.97
Consumed my time	4.24	4.16	4.35	4.29	4.10	4.09	4.30
Social development negatively impacted	2.69	2.73	2.64	2.68	2.87	2.71	2.58
Decreased my GPA in college	3.23	3.20	3.20	3.20	3.34	3.14	3.37
Increased expense	3.01	2.98	3.09	2.94	3.07	3.25	3.19
Decreased time spent working for wages	3.38	3.27	3.50	3.35	3.63	3.28	3.52
Personal academic standard lowered	3.27	3.22	3.29	3.24	3.50	3.30	3.33
Personal development negatively impacted	2.56	2.57	2.53	2.56	3.00	2.59	2.38
Personal health declined	3.27	2.87	3.01	2.91	3.30	3.04	2.97

Black indicates a value within .01 of the standard student average

Blue indicates a value above the standard student average

Red indicates a value below the standard student average

Table 5. P-values of student's perceived positive and negative outcomes

	P-Values
Intellectual development	**0.0001**
Personal development	**0.0001**
Social development	**0.0361**
Academic engagement	0.2014
Career and professional development	0.0631
Promote socialization of people of different backgrounds	0.6088
Civic development	0.6118
Develop leadership skills	**0.0452**
Connection with your discipline	**0.0018**
Opportunity to be independent and explore new areas	**0.0076**
Connecting with people who share your identity	0.3928
Academic engagement decreased	0.1423
Academic timeline extended	**0.0001**
Career and/or professional development declined	**0.0021**
Consumed my time	**0.0250**
Social development negatively impacted	**0.0001**
Decreased my GPA in college	**0.0017**
Increased expense	**0.0007**
Decreased time spent working for wages	0.2009
Personal academic standard lowered	0.0800
Personal development negatively impacted	0.2226
Personal health declined	0.6168

Table 6. Intellectual Development Response Distribution by Participation in Co-curricular

	Has Participated in a Co-curricular in the Past 12 Months	
Promotion Factor: Intellectual Development	No	Yes
Strongly Disagree	0.00%	0.00%
Disagree	0.47%	1.55%
Neutral	5.16%	4.65%
Agree	58.22%	34.50%
Strongly Agree	36.15%	59.30%

Table 7. Academic Timeline Extended Response Distribution by Participation in Co-Curricular

	Has Participated in a Co-curricular in the Past 12 Months	
Promotion Factor: Personal Development	No	Yes
Strongly Disagree	0.47%	0.00%
Disagree	3.29%	0.39%
Neutral	9.86%	10.47%
Agree	57.28%	37.21%
Strongly Agree	29.11%	51.94%

Table 8. Connection with your Discipline Response Distribution by Participation in Co-curricular

	Has Participated in a Co-curricular in the Past 12 Months	
Promotion Factor: Connection with your Discipline	No	Yes
Strongly Disagree	0.00%	0.30%
Disagree	1.87%	0.78%
Neutral	7.48%	7.75%
Agree	54.67%	37.96%
Strongly Agree	35.90%	53.10%

Table 9. Career and/or Professional Development Response Distribution by Participation in Co-curricular

	Has Participated in a Co-curricular in the Past 12 Months	
Prevention Factor: Career and/or Professional Development	No	Yes
Strongly Disagree	15.09%	29.02%
Disagree	64.15%	47.84%
Neutral	15.57%	16.08%
Agree	4.25%	5.10%
Strongly Agree	0.94%	1.96%

Table 10. Decreased my GPA in College Response Distribution by Participation in Co-curricular

	Has Participated in a Co-curricular in the Past 12 Months	
Prevention Factor: Decreased my GPA in College	No	Yes
Strongly Disagree	1.90%	6.02%
Disagree	14.22%	25.70%
Neutral	40.28%	30.92%
Agree	32.70%	26.10%
Strongly Agree	10.90%	11.24%

Table 11. Increased Expense Response Distribution by Participation in Co-curricular

	Has Participated in a Co-curricular in the Past 12 Months	
Prevention Factor: Increased Expense	No	Yes
Strongly Disagree	2.82%	9.02%
Disagree	19.72%	33.73%
Neutral	35.68%	26.67%
Agree	37.09%	24.71%
Strongly Agree	4.69%	5.88%

Table 12. Decreased Time Spent Working for Wages Distribution by Participation in Co-curricular

	Has Participated in a Co-curricular in the Past 12 Months	
Prevention Factor: Decreased Time Spent Working for Wages	No	Yes
Strongly Disagree	0.47%	7.09%
Disagree	15.49%	20.08%
Neutral	29.58%	27.56%
Agree	38.50%	32.28%
Strongly Agree	15.96%	12.99%

Table 13. Academic Timeline Extended Distribution by Participation in Co-curricular

	Has Participated in a Co-curricular in the Past 12 Months	
Prevention Factor: Academic Timeline Extended	No	Yes
Strongly Disagree	2.82%	10.98%
Disagree	17.84%	29.02%
Neutral	22.54%	23.538%
Agree	43.66%	26.67%
Strongly Agree	13.15%	9.80%

Appendix B

Full Survey Tool

Q1. Please verify that you are 18 years old or older and volunteer to participate

Q2. What is your gender Identity? Answer Choices: Cis-Woman Cis-Man Non-Binary Transgender Woman Transgender Man Genderqueer Unsure/Questioning Other (please specify)

Q3. What is your sex? Answer Choices: Female Intersex Male

Q4. How would describe your race(s) and/or ethnicity? Answered Skipped

Q5. What is your academic standing? Answer Choices: Freshman Sophomore Junior Senior Graduate

Q6. How many years have you attended Cal Poly? Answer Choices: 1 2 3 4 5+

Q7. Are you a first generation college student (neither of your parents completed a bachelor degree or higher) Answer Choices: Yes No

Q8. Are you an International student? Answer Choices: Yes No

Q9. What is your citizenship status? Answer Choices: US Citizen Permanent Resident Undocumented Immigrant Prefer Not to Answer

Q10. Are you a care provider (parent/ legal guardian or caregiver of a chronically ill, disabled, or aged person)? Answer Choices: Yes No

Q11. How many hours do you work (paid)? Answer Choices: 0 1-5 5-10 10-15 15-20 20+

Q12. Do you receive the Pell Grant? Answer Choices: Yes No

Q13. Do you receive Federal Work-Study support? Answer Choices: Yes No

Q14. Have you participated in a co-curricular activity in the past 12 months? Answer Choices: Yes No

Q15. During a typical recent academic session, how many hours per week would you estimate (on average) you spent working on a co-curricular project? Answer Choices: 0-5 5-10 10-20 More than 20

If students indicated they participated in a co-curricular activity in the last 12 months, they were asked about the factors which led to their participation, ranked on a Likert scale of 5 choices from "strongly disagree" to "strongly agree".

Q16. Because I agree with the message and goals of the club/organization and feel passionate about the objectives or main ideas of the project.

Q17. Because I could afford the financial cost/expense.

Q18. Because I had the time.

Q19. Because I read/heard about the activities.

Q20. Because of my parent or guardian's influence.

Q21. To be on par with other students in terms of involvement in activities.

Q22. To follow in the footsteps of older or former students who are now successful.

Q23. To break down barriers for and open new doors and to change perceptions of my race/ethnicity, religion, gender, or sexual orientation.
Q24. To create positive impact on campus / community.
Q25. To act on the encouragement from a faculty or advisor.
Q26. To fulfill my personal interest.
Q27. To gain skills and contacts that will make me more competitive in the job market.
Q28. To interact with students that look like me (e.g.,age,race, gender, etc).
Q29. To seek activities beyond coursework.
Q30. To try something new.

If students indicated they did NOT participate in a co-curricular activity in the last 12 months, they were asked about the factors which limited their participation, ranked on a Likert scale of 5 choices from "strongly disagree" to "strongly agree".

Q31. Cost/Expenses of joining were too high
Q32. Negative impressions of the club or the projects
Q33. Discouraged by faculty
Q34. Doesn't contribute to what I want to learn
Q35. Family influence, or personal matters
Q36. Gender issues (actual or expected negative experiences related to gender)
Q37. Wasn't interested in group/teamwork
Q38. Identity (e.g, I did not personally identify and/or relate to members of the group)
Q39. Uncomfortable with social aspect of the team
Q40. Couldn't find an activity that suited my interest
Q41. Lack of time
Q42. Lack of knowledge about the opportunities (e.g., didn't have much information, wasn't sure what was involved or didn't know what projects were available)
Q43. Lengthy, difficult membership process
Q44. Limit to number of participants; a competitive process to join
Q45. Race/ethnicity issues (e.g., not feeling welcomed because of race/ethnicity; seemed like non inclusive environment)
Q46. Social inertia (e.g., I joined another activity on or off campus and it became too hard to leave after joining)

ALL respondents, whether they participated or not, were then asked about their perceptions about the expected positive and negative outcomes from participation in a co-curricular project activity, again ranked on a 5 point Likert scale.

Expected positive outcomes:

Q47. Intellectual development (e.g. analytical skills, critical thinking skills, might indirectly boost academic performance)

Q48. Personal development (e.g., self-confidence, identity development)

Q49. Social development (e. g. learning how to collaborate or work in varied teams)

Q50. Academic engagement (e. g., active and collaborative learning in a relevant subject area, interaction with peers and faculty)

Q51. Career and professional development (e. g. would help me network with industry, or help me plan to attend graduate school, or connect to and enter the engineering job market, or work on valuable professional skills)

Q52. Promote socialization/understanding of people of different backgrounds/identities

Q53. Civic development (e. g., civic activism, help people with difficulty, community service, and voluntarism)

Q54. Develop leadership skills

Q55. Connection with your discipline (stronger feeling that you are an engineer, or working on meaningful problems connected to your major)

Q56. Opportunity to be independent and explore new areas

Q57. Connecting with people who share your identity

Expected negative outcomes:

Q58. Academic engagement decreased (e.g., the degree of attention, curiosity, interest, optimism, and passion that I showed lowered)

Q59. Academic timeline extended (e.g., extended time to graduate)

Q60. Career and/or professional development declined

Q61. Consumed my time therefore my schedule was less flexible and free time was reduced significantly

Q62. Social development negatively impacted (e.g., interpersonal relationships declined)

Q63. Decreased my GPA in college (not applicable to first year students)

Q64. Increased expense (e.g., cost of involvement)

Q65. Decreased time spent working for wages

Q66. Personal academic standard lowered (feels like reduced quality of work in classes or other areas, whether or not grades actually affected)

Q67. Personal development negatively impacted (non-engineering traits and interests and thoughts)

Q68. Personal health declined (e.g., physical health, mental health)